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SYMPTOM EVALUATION OF
ROOT-DISEASED TREES ON A
PROPOSED SEED ORCHARD SITE
MT. ADAMS RANGER DISTRICT

GIFFORD PINCHOT NATIONAL FOREST
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Symptom Evaluation of Root-Diseased Trees
on a Proposed Seed Orchard Site, Mt. Adams Ranger District,
Gifford Pinchot National Forest, Washington

by

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Abstract

A 90-acre seed orchard site was examined prior to tree felling and land clearing to evaluate symptom expression in three species of conifers (Douglas-fir, grand fir, and ponderosa pine) with root diseases. About three-quarters of the trees within infected areas had roots decayed by one of two principal root pathogens, *Armillaria mellea* and *Fomes annosus*, as determined from totally excavated root systems. Crown symptoms and root collar symptoms were accurate indicators of 14.5 percent of the root-diseased trees. Stain or decay at freshly-cut stump surfaces were reliable indicators of 43.4 percent of root-diseased trees. Surveys designed to record crown symptoms and root collar symptoms in similar stands will give accurate estimates of the extent of mortality and imminent mortality due to root diseases. However, examination of freshly-cut stump surfaces will detect more accurately the total number of root-diseased trees, especially if decay associated with butt wounds is not present. The recommendation to remove stumps from this site was justified due to the high incidence of infection.

Introduction

Root diseases caused by several pathogens, including *Armillaria mellea*, *Phellinus weiri*, and *Fomes annosus*, can cause substantial losses in mixed conifer stands east of the Cascade Mountains in Oregon and Washington (Goheen and Filip 1980, Filip and Goheen 1982, 1984). Disease symptoms include dead trees, deteriorating crowns, fungal mycelium at the root collar and major roots, and stain/decay on the cross-section of freshly-cut stumps (Hadfield and Johnson 1977, Filip and Schmitt 1979). Infected trees exhibit crown symptoms only after the root system has reached an advanced stage of deterioration, depending on site, tree species and size, and pathogen species.

In a study done by Wallis and Bloomberg (1981) in Douglas-fir stands on Vancouver Island, British Columbia, above-ground indicators, including mycelium at the root collar and stain/decay at the stump surface, proved statistically reliable in estimating the total number of infected trees and area occupied by *P. weiri*. This is extremely useful for forest managers who, because of time constraints and limited field crew expertise, use only above-ground indicators to estimate total extent of stand infection. Similar work is needed in other conifer species infected with one or more root pathogens.

In an evaluation done by Forest Pest Management in a mixed-conifer stand on the Naches Ranger District (old Tieton RD) 50 miles north of the Mt. Adams Seed Orchard, crown symptoms and root collar symptoms were accurate indicators of 58.8 percent of the root-decayed trees (Filip 1979). Following tree harvesting, symptoms in freshly-cut stump surfaces were reliable indicators to detect 72.5 percent of the root-decayed trees. *P. weiri*, *F. annosus*, and *A. mellea* were the main root pathogens present.

In 1983, Forest Pest Management crews surveyed 90 acres of a proposed seed orchard site on the Mt. Adams Ranger District (see Seed Orchard Site Evaluation, Mt. Adams RD, June 8, 1983, by Craig L. Schmitt). This mixed-conifer stand was found to contain large infection centers of *A. mellea* and smaller scattered centers of *F. annosus*. Since the District was planning to excavate all stumps from the site, this provided an excellent opportunity to relate above-ground symptoms to root condition.

Objectives

Objectives of this evaluation were to:

1. Determine if symptoms in the crowns, at the root collars, and on freshly-cut stump surfaces are associated with diseased root symptoms in three East Side conifer species.
2. Verify by total root excavation and examination of as many stumps as possible, the need to remove stumps because of the suspected widespread occurrence of root disease.

Methods

The area is a 90-acre proposed Douglas-fir, ponderosa pine, and western larch seed orchard site 7 miles north of Troutlake, Washington (Fig. 1). The stand is uneven-aged and composed primarily of Douglas-fir, grand fir, and ponderosa pine. The stand had evidence of recent salvage and partial removal entries.

In 1983, trees within visibly-affected areas were classified by species and crown condition. Crowns were rated on a scale of one to four, 1 = healthy full crown, 2 = slight crown thinning, 3 = crown thinning and branch mortality, and 4 = severely symptomatic or dead tree. Root collars were examined by excavating soil from around the root collar and one or two major lateral roots, and presence of ectotrophic mycelium of *P. weiri*, yellow-stringy decay caused by *A. mellea*, or white-stringy decay caused by *F. annosus* was recovered. Presence of butt wounds and dead cambium were noted on each tree. Each tree was marked with a numbered metal tag as close to the ground line as possible.

Less than 1 week following harvesting, the stump surface of each tree was examined for presence of stain or decay. Stain (incipient decay) was distinguished from advanced decay by ease of penetration of a knife point. No attempt was made to measure the amount of stain or decay at the stump surface. Root pathogens causing the decay were tentatively identified. Presence and extent of wet wood were not recorded.

All stumps on the site were excavated with a D-8 bulldozer. The entire root system of each stump was examined and recorded by tag number, root pathogen(s), and percent of root system decayed as ocularly estimated. Occasionally, decayed wood was collected, and wood chips (2x2x5 mm) were cultured on two percent malt agar media to positively identify root pathogens.

Results and Discussion

One-hundred and eight trees (67 grand fir, 34 Douglas-fir, and 7 ponderosa pine) were examined for crown condition, root collar condition, stump surface condition, and were excavated totally to assess root condition. Over three-quarters of the excavated stumps had roots decayed by one of two root pathogens; *A. mellea* or *F. annosus* (Table 1). Decay caused by *F. annosus* was found primarily in grand fir, and three trees containing this pathogen were dead. Decay caused by *A. mellea* was found in all species, and two grand fir and three Douglas-fir with this fungus were dead. No dead ponderosa pines were found.

In trees with healthy root systems, as determined after stump excavation, 96.0 percent had healthy crowns or only slight crown abnormalities (rating 1 or 2), while 4.0 percent had thin, ragged, chlorotic, or dead crowns (rating 3 or 4). In trees with decayed root systems, 85.5 percent had crowns rating 1 or 2 and 14.5 percent had crowns rating 3 or 4 (Table 2). However, trees with crown symptoms had considerably more root decay than trees without crown symptoms. Trees decayed by *A. mellea* showed slightly fewer crown symptoms than trees decayed by *Fomes annosus*.

Only 4.0 percent of the trees with healthy root systems had root collar symptoms (Table 3). In trees with decayed roots, only 15.5 percent of the trees had root collar symptoms. As with crown systems, trees with root collar symptoms had more root decay than trees without root collar symptoms. Only mycelial fans and dead cambium were used as root collar symptoms of root disease. Correlation of butt wounds to root decay was poor since nearly as many trees with healthy roots had wounds as did trees with decayed roots. However, wounded trees had considerable stain or decay at the wound site that often was not present in the root systems.

In trees with healthy root systems, 44.0 percent of the stump surfaces had either stain or decay present. Most of this was associated with butt wounds in grand fir, and decay was confined to the wound site. In trees with decayed roots, 43.4 percent of the stump surfaces had either stain or decay present. Considerably more stain or decay was associated with *F. annosus* (76.5 percent of stumps) than with *A. mellea* (34.9 percent of stumps). With *A. mellea*, only grand fir showed stain or decay of the stump surface; infected Douglas-fir and ponderosa pine showed little or no stain or decay at the stump surface. In grand fir with decayed roots, 69.4 percent of the stump surfaces had stain or decay present. In general, the degree of decay at the stump surface increased with the amount of root decay.

Conclusions and Recommendations

In mixed-conifer stands similar to the one examined here, crown symptoms and root collar symptoms can be used to give accurate estimates of the extent of mortality and imminent mortality due to root diseases, especially in stands with a heavy component of grand fir. However, the total number of root-diseased trees would have been underestimated by over 75 percent in this stand if crown symptoms or root collar symptoms alone were relied upon, particularly in trees that had less than one-third of their root systems decayed. A better estimate (44 percent) of the extent of trees with root decay on a site can be obtained by examining the cut surface of recently harvested trees for stain or decay. However, trees with less than a third of their root systems decayed may not even show stain or decay at the stump surface, especially Douglas-fir and ponderosa pine. Also, grand fir may show stain or decay of the stump surface that is associated with butt wounds rather than root infections.

By using linear regression, Wallis and Bloomberg (1981) found a significant correlation between the number of trees with above-ground indicators and total number of *P. weiri*-infected trees, a correlation that was not improved by examining root collars or stump surfaces also. Because of this, they recommend that the time spent in uncovering and recording mycelium at the root collar or stain/ decay on the stump surface is not justified. However, in mixed conifer stands often infected with two or more root pathogens, examination of root collars (and possibly culturing also) is the only way to positively identify species of root pathogen(s) involved. Such identification is critical for disease management where control measures may differ, depending on species of root pathogen present. In the current area examined, excavation of infected stumps will minimize damage caused by all root pathogens in the future seed orchard. However, in infected stands where stump excavation is not feasible and a change to more resistant conifer species is recommended, identification of root pathogen(s) involved may be critical since conifer resistance may differ, depending on the species of root pathogen present.

The June 8, 1983 recommendation to remove stumps from this proposed seed orchard site was justified since over three-quarters of the stumps that were examined were infected. Over three-quarters of the infections were *A. mellea*, which can cause substantial losses in Douglas-fir, western larch, and ponderosa pine, species to be planted on the site.

It is recommended that future seed orchard or evaluation plantation sites having trees with crown symptoms, root collar symptoms, or recently cut stumps with stain or decay be further evaluated for extent of root disease. The presence of root diseases may require that stumps be excavated before the site can be planted safely.

The information and recommendations presented in this report have been specifically formulated for the area we examined. Although some of this information may be applied to other areas experiencing similar root disease problems, these areas may differ sufficiently from the area we surveyed to warrant a separate biological evaluation. Forest Pest Management pathologists encourage and are available to perform such evaluations at the request of land managers.

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Table 1.--Incidence of Principal Root Pathogens Causing Decay in 108 Excavated Stumps by Tree Species, Mt. Adams Ranger District, Gifford Pinchot National Forest, WA

<u>Tree Species</u>	<u>Number Examined</u>	<u>Number Decayed</u>	<i>Fomes annosus</i>	<i>Armillaria mellea</i>
-----Number of Stumps-----				
Grand fir	67	49	15	34
Douglas-fir	34	28	2	26
Ponderosa pine	7	6	0	6
Total	108	83	17	66
Percent	100	76.9	20.5	79.5

Table 2.--Relationship Between Crown Condition and Condition of Root Systems by Tree Species, Mt. Adams Ranger District, Gifford Pinchot National Forest, WA

<i>Armillaria mellea</i>						
<u>Tree Species</u>	<u>Trees With Healthy Roots</u>			<u>Trees With Decayed Roots</u>		
	<u>Number Examined</u>	<u>Crown Symptoms Rating 3-4</u>	<u>No Crown Symptoms Rating 1-2</u>	<u>Number Examined</u>	<u>Crown Symptoms Rating 3-4</u>	<u>No Crown Symptoms Rating 1-2</u>
-----Number of Trees-----						
Grand fir	4	0	4	34	3(58) ^{a/}	31(30)
Douglas-fir	5	0	5	26	5(75)	21(24)
Ponderosa pine	1	0	1	6	0	6(33)
Total	10	0	10	66	8(69)	58(28)
Percent			100.0		12.1	87.9
 <i>Fomes annosus</i>						
Grand fir	14	1	13	15	4(35)	11(23)
Douglas-fir	1	0	1	2	0	2 (8)
Total	15	1	14	17	4(35)	13(21)
Percent		6.7	93.3		23.5	76.5

a/ Number in parentheses is the mean percentage of root system decayed.

Table 3.--Relationship Between Root Collar Condition and Condition of Root Systems by Tree Species, Mt. Adams Ranger District, Gifford Pinchot National Forest, WA

Armillaria mellea

Tree Species	Trees With Healthy Roots			Trees With Decayed Roots		
	Number Examined	Root ^a /Collar Symptoms	No Root Collar Symptoms	Number Examined	Root Collar Symptoms	No Root Collar Symptoms
-----Number of Trees-----						
Grand fir	4	0	4	34	4(63) ^b /	30(28)
Douglas-fir	5	1	4	26	5(65)	21(33)
Ponderosa pine	1	0	1	6	0	6(33)
Total	10	1	9	66	9(64)	57(30)
Percent		10.0	90.0		13.6	86.4

Fomes annosus

Grand fir	14	0	14	15	3(20)	12(28)
Douglas-fir	1	0	1	2	0	2 (8)

Total	15	0	15	17	3(20)	14(25)
Percent		0	100.0		17.7	82.3

a/ Root collar symptoms include mycelial fans (*Armillaria*) and dead cambium.

b/ Number in parentheses is the mean percentage of root system decayed.

Table 4.--Relationship Between Stump Surface Condition and Condition of Root Systems by Tree Species, Mt. Adams Ranger District, Gifford Pinchot National Forest, WA

Armillaria mellea

Tree Species	Number Examined	Trees With Healthy Roots			Trees With Decayed Roots			
		Stump Surface With			Number Examined	Stump Surface With		
		No Stain or Decay	Stain	Decay		No Stain or Decay	Stain	Decay
-----Number of Stumps-----								
Grand fir	4	2	1	1	34	12(27) ^{a/}	12(40)	10(29)
Douglas-fir	5	5	0	0	26	25(29)	1(75)	0
Ponderosa pine	1	1	0	0	6	6(33)	0	0
Total	10	8	1	1	66	43(29)	13(43)	10(29)
Percent		80.0	10.0	10.0		65.2	19.7	15.2

Fomes annosus

Grand fir	14	6	5	3	15	3(12)	6(28)	6(31)
Douglas-fir	1	0	1	0	2	1(5)	1(10)	0
Total	15	6	6	3	17	4(10)	7(25)	6(31)
Percent		40.0	40.0	20.0		23.5	41.2	35.3

a/ Number in parentheses is mean percentage of root system decayed.

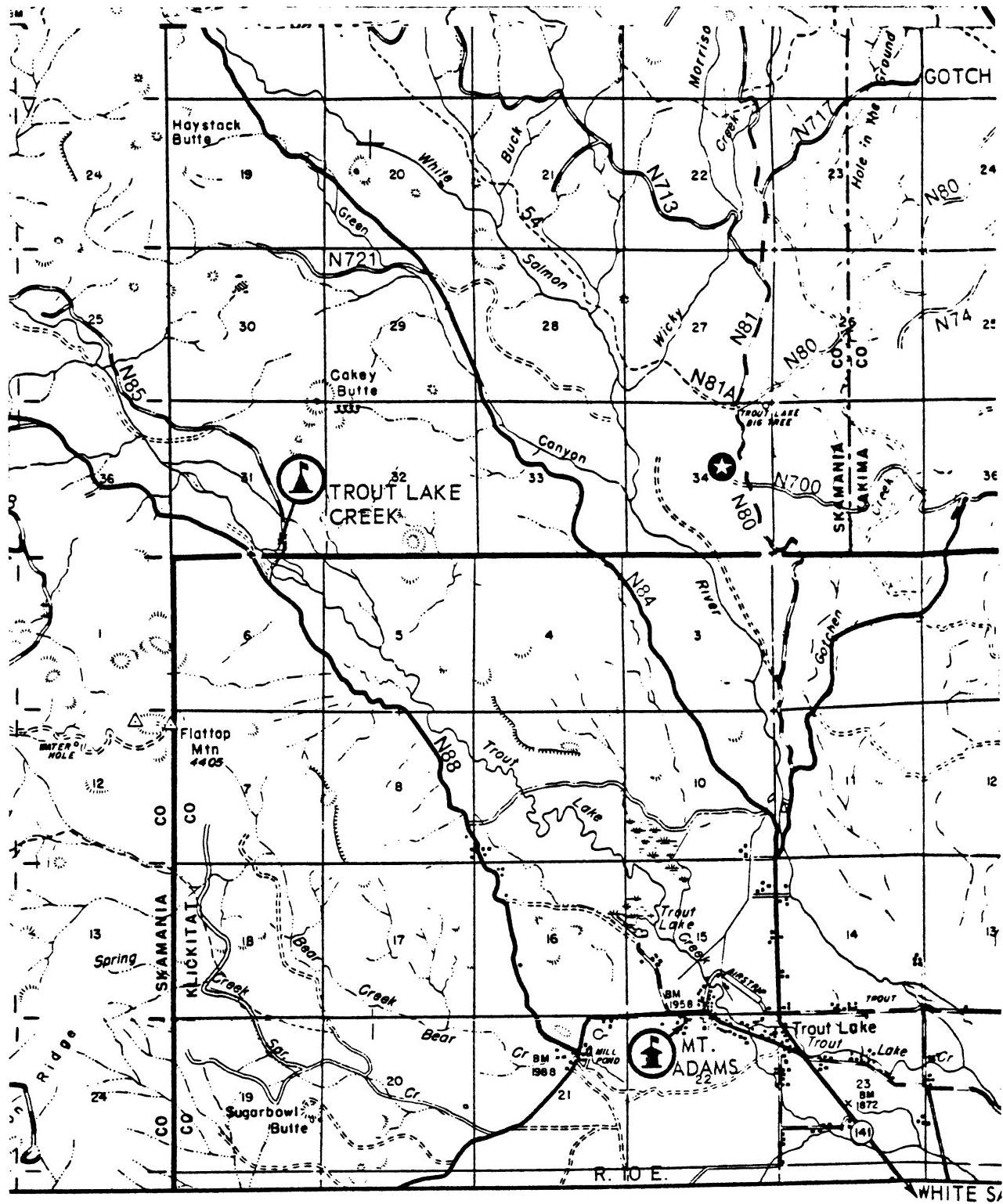


Figure 1.--Map showing location (star) of area evaluated for root disease symptoms on the Mt. Adams Ranger District.